PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : F02B 37/04 — A1

(11) International Publication Number: WO 92/04536

(43) International Publication Date: 19 March 1992 (19.03.92)

(21) International Application Number: PCT/SE91/00584

(22) International Filing Date: 5 September 1991 (05.09.91)

(30) Priority data:
9002849-9 6 September 1990 (06.09.90) SE

(71) Applicant (*for all designated States except US*): AB VOLVO PENTA [SE/SE]; S-405 08 Göteborg (SE).

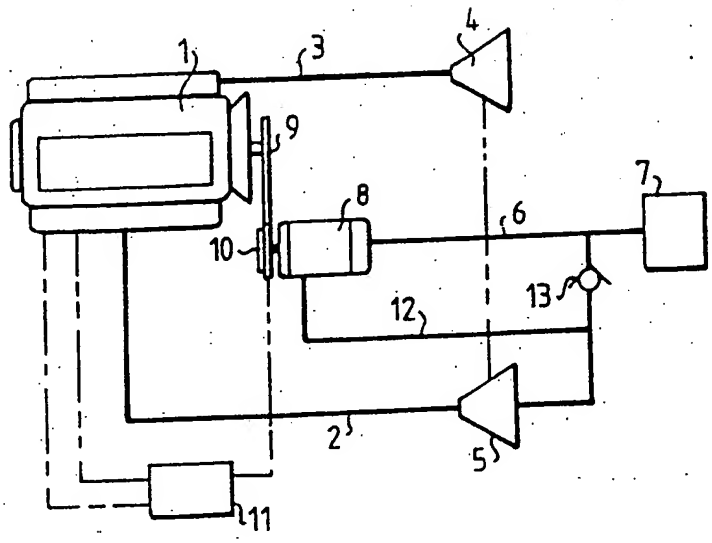
(72) Inventors; and
(75) Inventors/Applicants (*for US only*) : ANDERSSON, Bertil [SE/SE]; Agnsjödalsvägen 6476, S-434 96 Kungsbacka (SE). ANDERSSON, Peder [SE/SE]; Huke. Pl. 2112, S-417 46 Göteborg (SE). ANDERSSON, Kurt [SE/SE]; Klövervägen 12, S-430 94 Bohus Björkö (SE). OLAUSSON, Arnold [SE/SE]; Gjutargårdsvägen 5, S-439 00 Onsala (SE).

(74) Agents: KIERKEGAARD, Lars-Olov et al.; H. Albihns Patentbyrå AB, Box 3137, S-103 62 Stockholm (SE).

(81) Designated States: AT (European patent), AU, BE (European patent), BR, CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: SUPERCHARGED INTERNAL COMBUSTION ENGINE



(57) Abstract

The invention relates to a supercharged internal combustion engine (1) with a mechanical compressor (8) and a turbo-compressor (4, 5), which are coupled in series. The turbo-compressor is coupled downstream of the mechanical compressor. Between the connection (12) of the latter with the suction side of the turbo-compressor and the air intake (7) of the turbo-compressor, there is a non-return valve (13) arranged, which opens towards the turbo-compressor when the air requirement of the turbo-compressor exceeds the capacity of the mechanical compressor.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU+	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE*	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

+ Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

Supercharged internal combustion engine

The present invention relates to a supercharged internal combustion engine comprising an exhaust driven turbo-compressor and a compressor mechanically driven by the engine, the pressure side of said compressor being connected to the suction side of said turbo-compressor, and means for suspending the effect of the mechanical compressor on the supercharging of the engine.

It is a known fact that a supercharged diesel engine with a high average pressure always has the disadvantage that its torque at low and medium r.p.m. is low. In order to obtain high power, the turbo unit must be optimized towards high boost pressure in the high r.p.m. range, which has the effect that the boost pressure will be relatively low in the lower r.p.m. range, since the available exhaust energy within this range is often insufficient to drive the turbo unit. This in turn leads to higher exhaust emissions, primarily in the form of soot and particle formation, and low torque with resulting poor acceleration. The problem becomes especially pronounced in heavy planing boats, which have a complicated resistance curve. Under certain conditions, for example in heavy seas running head on, it can be difficult to push the boat over its planing threshold.

It is known e.g. by US-4 258 550 to compensate the relatively poor boost pressure of a turbo compressor at low r.p.m. with a mechanically driven compressor which is coupled in series with the turbo-compressor as described by way of introduction, i.e. the pressure side of the mechanical compressor is connected to the suction side of the turbo-compressor. This produces a boost pressure on the pressure side of the turbo-compressor which is a result of the combined effect of the two compressors. In the known system disclosed in said patent specification, a pair of valves are arranged which are switched over when sufficient charge

pressure can be achieved with the turbo-compressor alone so that the pressure side of the mechanical compressor is connected to a charge air cooler for the turbo-compressor at the same time as the turbo-compressor's suction side is reconnected from the pressure side of the mechanical compressor directly to an air intake.

The purpose of the present invention is in general, starting from the above mentioned known series coupling of a mechanical compressor and a turbo-compressor, to achieve a supercharged internal combustion engine of primarily diesel type, in which the charge pressure can, with simple means, be optimized for the high r.p.m. range as well as the low and medium r.p.m. ranges. In particular, it is intended to provide a supercharged diesel engine particularly suited to heavy planing boats, which provides sufficient propelling force even in the lower r.p.m. range, within which the boat is to overcome its planing threshold.

This is achieved according to the invention in a supercharged internal combustion engine of the type described by way of introduction by virtue of the fact that said means comprise valve means arranged between the connection point of the mechanical compressor to the suction side of the turbo-compressor and the air intake of the turbo-compressor, said valve means being disposed to be kept closed as long as the amount of air delivered by the mechanical compressor is greater than the air requirement of the turbo-compressor, and to open when the air requirement of the latter exceeds the capacity of the former.

By making the air requirement of the turbo-compressor one of the parameters controlling the interaction between the compressors, it is possible to achieve a relatively simple and inexpensive installation. In the simplest embodiment, said valve means can be formed by a simple mechanical non-return valve, which automatically opens towards the suction side of the turbo-compressor when the pressure on said side drops below the pressure on the air intake side of said

valve. In a further development of the invention, the valve can cooperate with control means which disengages a clutch arranged between the engine and the mechanical compressor when the valve opens.

The invention will be described in more detail with reference to examples shown in the accompanying drawings, of which Figs 1 and 2 show schematically two diesel engines representing two different embodiments of the compressor system.

In Fig 1, 1 designates an internal combustion engine of diesel type, 2 the engine intake conduit and 3 its exhaust conduit. A turbo-compressor, consisting of a turbine portion 4 and a compressor portion 5, is connected in the conventional manner in the intake conduit 2 and the exhaust conduit 3. The intake conduit 2 is branched from a conduit 6 between an air filter 7 and the suction side of a compressor 8 mechanically driven by the engine 1. This can be of any known type at all, but preferably of displacement type, e.g. a screw compressor, which is driven directly by the engine crank shaft via a V-belt transmission with the general designation 9.

Furthermore, there is an electromagnetic clutch 10 between the drive shaft of the mechanical compressor 8 and its belt pulley. The engagement and disengagement of the clutch is controlled by an electric control unit 11, into which signals are fed representing engine r.p.m. and load (marked by dash/dot lines in Fig 1). The pressure side of the compressor 8 is coupled via a conduit 12 to the intake conduit 2 upstream of the turbo-compressor but downstream from a mechanical non-return belt 13, which can be of any suitable known type, e.g. a valve with a closing element in the form of a spring-biassed flap.

The engine installation described functions as follows:

When the engine 1 is at idle, the magnetic clutch 10 is disengaged and the compressor 8 is thus at rest. As the

throttle is slowly opened, with accompanying slow increase in r.p.m., the mechanical compressor 8 is engaged at a predetermined r.p.m., for example ca 1500 r.p.m. The engagement is thus dependent on r.p.m. when the throttle is opened slowly and the load increases slowly. If, however, signals indicating a sharp increase in load, at an engine speed below the engagement r.p.m., are received by the control unit 11, the mechanical compressor 8 is engaged earlier so that the required charge pressure is always obtained.

At increasing load on the engine 1, the turbo-compressor 4,5 will assume a larger and larger proportion of the total charged pressure, and when the turbo-compressor requires more air on the suction side than what the mechanical compressor is able to deliver, the non-return valve 13 will open automatically since the pressure downstream of the non-return valve 13 will then be less than the pressure on the air filter side. The mechanical compressor 8, after the non-return valve is opened, will have no function and in order to reduce the energy consumption of the engine and noise as well as reduce wear to the compressor 8, this should be turned off at this stage. This can also be effected via the control unit by storing a predetermined turn-off r.p.m., for example 3.000 r.p.m., in the control unit or via signals to the control unit indicating that the non-return valve is open.

In Fig 2, an engine installation is shown which differs from that described above only as regards the valve means and their control. Components corresponding to those in Fig 1 have been given the same reference numerals as in Fig 1. Instead of a simple mechanical non-return valve, the valve is in the form of an electrically operated on-off valve 14 arranged in the intake conduit 2. The turning on and off of the valve 14 is controlled by the control unit 11 in response to signals from a pair of pressure sensors 15 and 16, respectively, on the suction and pressure sides, respectively, of the mechanical compressor 8. The control unit is thus disposed to open the valve 14 when the signals

sent to the control unit by the pressure sensors 15,16 indicate that the pressure on the suction and pressure sides are equal. These signals are also used to simultaneously turn off the mechanical compressor.

Claims

1. Supercharged internal combustion engine, comprising an exhaust-driven turbo-compressor and a compressor mechanically driven by the engine, the pressure side of said compressor being connected to the suction side of said turbo-compressor, and means for suspending the effect of the mechanical compressor on the supercharging of the engine, c h a r a c t e r i z e d in that said means comprise valve means (13;14) arranged between the connection point of the mechanical compressor (8) to the suction side of the turbo-compressor (4,5) and the air intake (7) of the turbo-compressor, said valve means (13;14) being disposed to be kept closed as long as the amount of air delivered by the mechanical compressor is greater than the air requirement of the turbo-compressor, and to open when the air requirement of the latter exceeds the capacity of the former.

2. Engine according to Claim 1, c h a r a c t e r i z e d in that said valve means are formed by a non-return valve (13), disposed to open towards the suction side of the turbo-compressor (4,5) when the pressure on said side drops below the pressure on the side of the valve facing the air intake (7).

3. Engine according to Claim 1, c h a r a c t e r i z e d in that said valve means are formed of an on-off valve (14), which, via control means (11) is coupled to pressure sensors (15,16) on the suction and pressure sides of the mechanical compressor (8) and which is arranged to open when the pressures on the suction and pressure sides are equal.

4. Engine according to any one of Claims 1-3, c h a r a c t e r i z e d in that the mechanical compressor (8) is driven by the engine via a clutch (10) which can be turned on and off, and that said valve means (14) cooperate with the control means (11), which disengage the compressor when the valve means open the connection between the suction side of the turbo-compressor and the air intake.

5. Engine according to anyone of Claims 1-4, c h a r a c t - e r i z e d in that the mechanical compressor (8) is of displacement type.

6. Engine according to anyone of Claims 1-5, c h a r a c t - e r i z e d in that the engine (1) is a marine diesel engine.

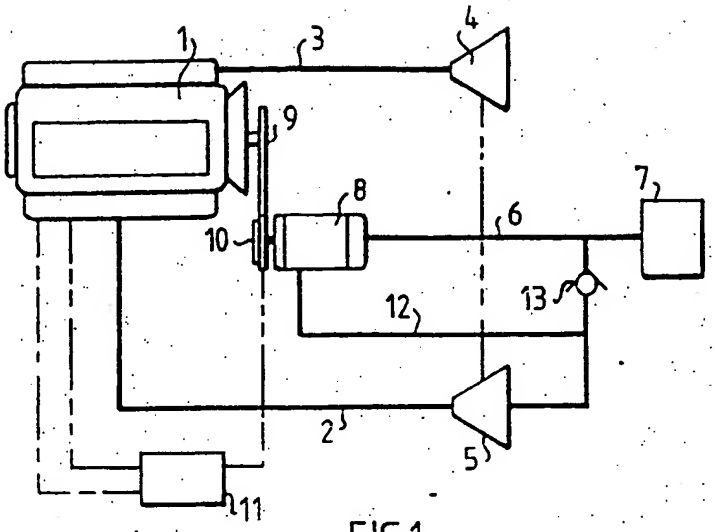


FIG.1

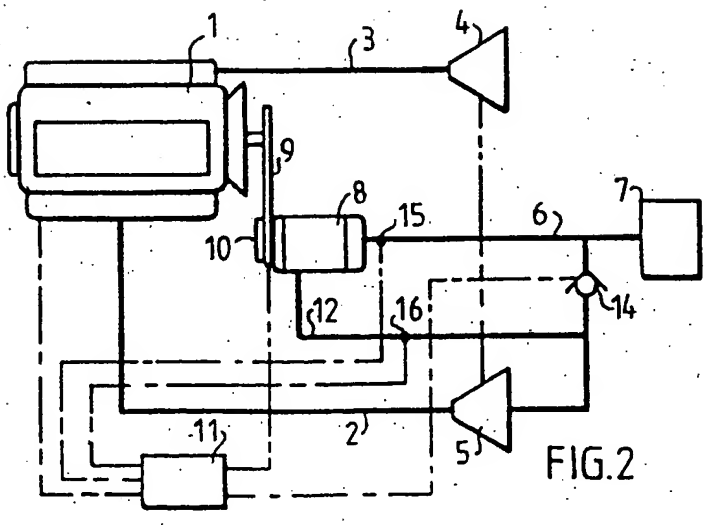


FIG.2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00584

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 02 B 37/04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 02 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US, A, 4258550 (HINKLE ET AL) 31 March 1981, see the whole document --	1-6
A	US, A, 3595013 (M.G. BRILLE ET AL) 27 July 1971, see the whole document --	1-6

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9th December 1991	1991 -12- 10
International Searching Authority: SWEDISH PATENT OFFICE	Signature of Authorized Officer: Krister Bengtssonh

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00584

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 31/10/91
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 4258550	81-03-31	CA-A-	1128762	82-08-03
		GB-A-B-	2051232	81-01-14
		JP-C-	1372859	87-04-07
		JP-A-	56000520	81-01-07
		JP-B-	61038328	86-08-28
US-A- 3595013	71-07-27	DE-A-B-C	1903261	69-10-16
		DE-A-	1966223	71-12-30
		FR-A-	1577300	69-08-08
		GB-A-	1262138	72-02-02
		NL-A-	6901730	69-08-11
		FR-A-	1594570	70-06-08
		FR-A-	1587670	70-03-27
		FR-E-	96336	72-06-16

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☑ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.